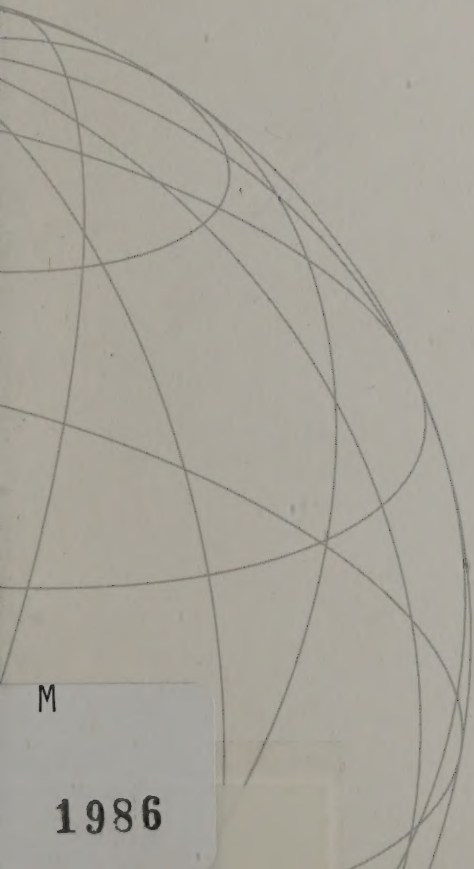
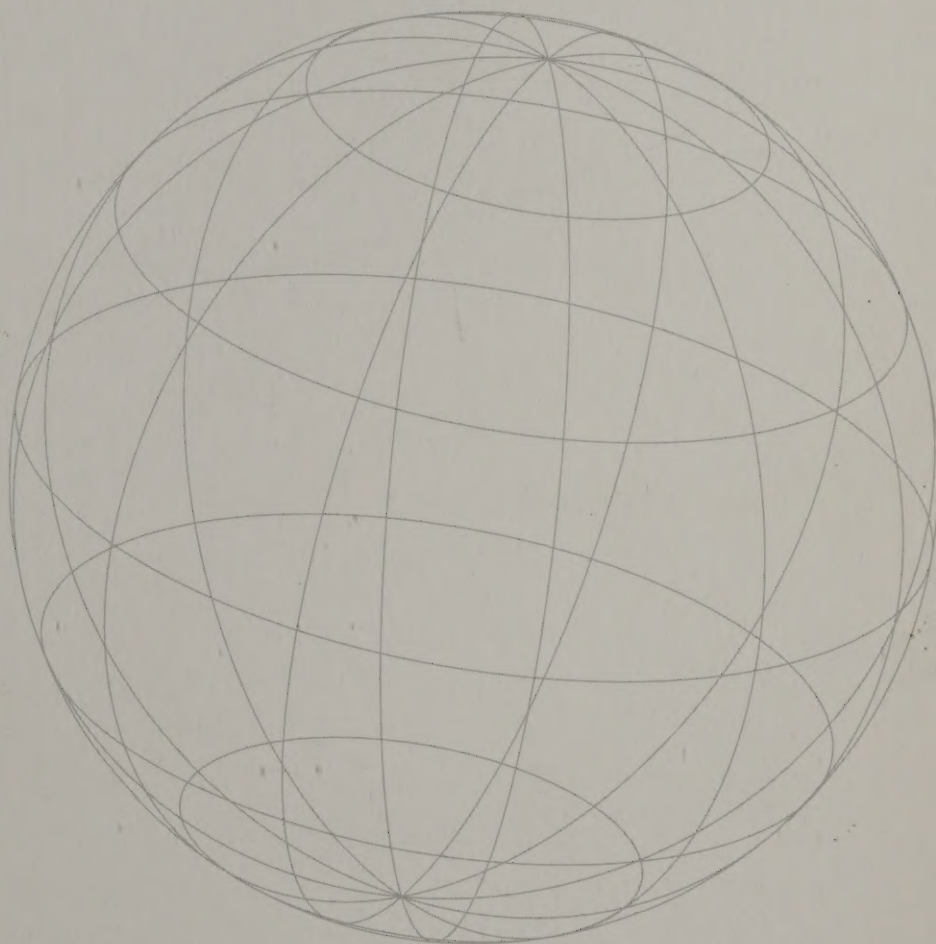


Report of the  
Science Strategy  
Review Group





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**REPORT**

**OF**

**SCIENCE STRATEGY REVIEW GROUP**

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RESEARCH STRATEGY REVIEW GROUP

## REPORT OF SCIENCE STRATEGY REVIEW GROUP

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## SUMMARY

### Remit

The Science Strategy Review Group was appointed by Mr Henry McLeish, MP, MSP, and Minister for Enterprise and Lifelong Learning, to complete a project by the end of January 2000 with the following remit:

“To identify the questions that need to be addressed in order to put in place a Science Strategy for the Scottish Executive; and to identify what additional mechanisms would be required to answer these questions and to implement such a strategy.”

### Key Questions

Some major questions for a Scottish science strategy are: how best to link the provision and use of science with economic growth and wealth generation in Scotland; how to foster technology transfer and uptake; how to stimulate entrepreneurship; and how to target investment in science and technology with this in mind. These are key areas where a concerted “policy for science”, and a strategic approach linking the science base with industry, might yield considerable benefits.

Another important set of questions for a science strategy relates to the use of science in formulating and implementing Government policy (“science for policy”), particularly with regard to enhancing the quality of life in Scotland in areas like health and the environment. There are a number of scientific advisory systems already in existence both within Scotland and at the UK level, and a strategy would need to identify: how to provide an advisory framework which builds on these systems in a co-ordinated way; how to ensure the best and most relevant scientific advice is available to Scottish Ministers and the Executive; how to ensure improved coherence and consistency within the Scottish Executive for the provision of science to underpin aspects of policy making; and how to encourage a greater use of evidence-based policy making.

Science issues are increasingly being brought into public debate. A science strategy for Scotland could provide a catalyst for stimulating open and knowledgeable debate on scientific matters of public interest and concern. This would sit well with the inclusive approach to government espoused by the Executive. A strategy would need to set out how this is to be achieved.

A further key set of questions for a science strategy relates to science education in primary and secondary schools where an even greater attention to general “scientific literacy”, to the application of science, and to more specialist scientific training, could have multiple benefits for Scotland. In time this would lead to the development of a greater degree of public understanding of science, to the provision of high quality science graduates for the future science base in Scotland, and to an improved awareness of the potential of science and technology within business and industry. Questions here relate to the school curriculum, to maintaining and improving levels of attainment, to scientific training for primary school teachers, and to continuing professional development for secondary school teachers.

Since all these matters require support and input from a science base, a key question for a science strategy would be how best to manage and co-ordinate the continuing strong science



base in Scotland, including the prioritisation of investment in research. It would be essential to balance the need to continue to drive the science base towards the advancement of knowledge through the pursuit of scientific curiosity, with the need to ensure that that new knowledge is transferred and used in key ways, to the benefit of Scotland as well as more widely.

Finally, however, a Scottish science strategy would have to link into, contribute towards, and be consistent with, policy for science at the UK level. To some extent a strategy would be reliant for its effectiveness on agencies such as the Research Councils and various scientific advisory committees which operate at the UK or European levels and are not under the direct control of the Scottish Executive. A Scottish science strategy would therefore have to build upon this relationship with the UK and international science base but bring added value by drawing together aspects of science policy which are particularly Scottish and highlight the contribution which Scottish science can make to the UK and international stage. How this might be done is another question for a strategy.

### Additional Mechanisms

All these issues are interlinked and demonstrate the case for developing a coherent and co-ordinated Scottish science strategy. That strategy will build on the strengths of the science base in Scotland, link the various streams of science activity in Scotland, help facilitate the development of overarching objectives and priorities for science in Scotland, and provide a framework within which the Scottish Executive can exercise its devolved powers in relation to science and research.

Additional mechanisms will require, however, to be put in place if such a strategy is actually to be implemented and make a difference. These include a new external high level strategic advisory body, a strengthened central science capability within the Scottish Executive, and the active involvement of Ministers in science issues which cross the boundaries of their portfolios.



## INTRODUCTION

1. The Science Strategy Review Group was appointed by Mr Henry McLeish MP, MSP, and Minister for Enterprise and Lifelong Learning, in September 1999 to complete a project by the end of January 2000 with the following remit:

“To identify the questions that need to be addressed in order to put in place a Science Strategy for the Scottish Executive; and to identify what additional mechanisms would be required to answer these questions and to implement such a strategy.”

2. The Group's approach was, first of all, to consider the range of issues involving science in modern-day Scotland under four main headings, namely the role of science: in wealth creation in the economy; in Government policy making and implementation; in dealing with matters of public concern; and in the education system particularly in schools. The Group then identified the issues which such a strategy would need to address so far as the Scottish science base is concerned, and then also the UK and international context in which a Scottish science strategy would need to operate. Finally the Group considered why it seems both timely and necessary to address all these issues within a single science strategy, and identified the processes which it felt would need to be put in place in order to develop and implement a strategy. The report is accordingly set out on these lines.

3. For the purposes of this exercise the Group wished to interpret “science” to encompass engineering and technology (or the application and use of science in systems and materials in the physical world), and also to include social science as well as the physical and life sciences.

4. The membership of the Group is set out at the Annex to this Report and it met on two occasions with additional work being carried out on its behalf by officials of the Scottish Executive. The Group see their Report as an important step towards developing a science strategy for the Scottish Executive and for Scotland.

## SCIENCE AND THE ECONOMY

5. Science and technology are key drivers in a modern economy and so are very important to the future economic development and prosperity of Scotland. Yet while it is widely felt that Scotland is proportionately stronger than the UK in the quality of its scientific research, there is a widespread view that its track record in exploiting the outputs of its science and engineering base could be improved. How to achieve this would be a central question to be addressed by a science strategy (in addition to the attention it is receiving under the Scottish Executive's parallel cross-cutting initiative on the Knowledge Economy).

6. A first task is to identify what are the economic drivers and strengths in Scotland and how the current or potential scientific strengths in Scotland could influence them. Scottish Enterprise (SEn) have recently published their strategy for economic development focusing on the cluster concept, having initially identified four sectors of importance to the Scottish economy with related expertise in the science base. The cluster concept is based in part on the premise that R&D intensive businesses respond to new ideas and technologies emerging from the science base. However, success in linking a science strategy more generally to the stimulation of the Scottish economy will be dependent on other inputs such as Foresight exercises. In addition a science strategy should both draw upon and inform an analysis of



the strengths and weaknesses of the Scottish economy. In this way a better matching of economic needs with scientific strengths might be achieved, and arrangements put in place to support priority business sectors, especially the SME sector. The question here is therefore how best to link a science strategy into a related economic framework for Scotland.

7. It is, however, the Group's view that one of the key constraints on good technology transfer in Scotland is the lack of "industry pull" to match "technology push". Many higher education institutions are very active in the commercialisation of research. There is a pressing need, however, to promote more business investment in research and development in Scotland. Such investment is strongly correlated with economic performance and creates a positive feedback by enhancing industry's capacity to exploit innovation. This could be an area for strategic intervention by the Scottish Executive. Here the question is how to foster increased "industry pull" in Scotland (although this raises wider issues beyond the scope of a science strategy).

8. Related to this are the questions concerning entrepreneurship and business appreciation among scientists and engineers, and questions of technology management in business and industry. It may be that there are simply too few people in the academic and business worlds with the knowledge and skills to understand how technological opportunities might be exploited, or to identify and understand potential markets for innovation and new products. As to technology management, a lack of managers with the appropriate mix of knowledge and skills has been highlighted as a general UK weakness. UK industry is now investing directly in US R&D, partly in order to utilise the management capacity available in the US to take initiatives through to the market place. These skills issues could have implications for the education system. This may also be something for the Scottish Executive's Knowledge Economy Taskforce to address.

9. A science strategy should be able to contribute to these issues by setting out measures and mechanisms to facilitate technology transfer at the interface between academic research and industry. There already are excellent examples of dynamic industry-academe collaborations, with funding coming from a number of different sources. But these should be built upon. A question here is how best to do so? Related to that, the public sector currently provides good support for research but not for development. The question here is whether in Scotland there should be an additional emphasis on supporting pre-competitive development and application, and whether increased public funding should be made available for this purpose (we are aware of recent developments on this front such as the Scottish Enterprise "Proof of Concept" fund). A science strategy, together with the knowledge economy initiative, could bring together the necessary mechanisms to address the crucial question of how to improve technology transfer across the academic/industry interface.

10. Finally, in this context the Review Group note that SHEFC and Scottish Enterprise have worked closely together in the first Knowledge Economy Taskforce and, with the Royal Society of Edinburgh, in the Technology Ventures programme. Each has complementary roles and a question for a science strategy therefore is how to ensure that they work together in new strategic initiatives to improve the relevance of the science base to the future of the Scottish economy.



## SCIENCE AND GOVERNMENT POLICY

11. Science is an integral part of policy-making in technologically-advanced countries of the world. It has the potential to contribute to the formulation of a wide range of policies and their implementation by the Scottish Executive, particularly in areas such as health and the environment and where the rate of technological development is high and accelerating. The Scottish Parliament is likely to stimulate a new interest in this. In preparation for this greater degree of scrutiny and accountability, the Scottish Executive should foster an increasingly objective and evidence-based approach to policy making. To achieve this it will be important for scientists and Scottish Executive officials to work closely together on "policy foresight" exercises and to help with the task of identifying future policy issues and related policy research requirements. A science strategy will have to address the question of how to achieve this and in particular how to engage the social sciences not only in the development of the Executive's social policies but also in the development of its economic and environmental policies as well.

12. Accordingly the Executive needs pragmatic, secure and rapid sources of scientific information and advice. It also requires efficient systems to identify future needs for research against a rapidly-changing backcloth. The most problematic scientific issues arise, however, when an issue is complex or where there is some degree of scientific uncertainty or disagreement over the interpretation of facts. This underlines the need to take advice from the most able group of scientists, whether or not they are located in Scotland, particularly on how to handle uncertainty and the risk of attaching to it. In the Group's view, therefore, Scotland should continue to draw on the UK and European structures already in place for providing scientific advice, and if necessary go further afield for specific advice.

13. It will also be necessary, however, to maintain Scottish-based scientific advice. Understandably, Whitehall may not always take full account of Scottish or specific regional circumstances in addressing issues that require scientific input. Ideally, scientific advisory systems in Scotland should complement those already in place in Whitehall. The question here is how to define and put in place a Scottish scientific advisory system which is integrated where necessary into UK and European systems, and which at the same time ensures that the best and most relevant scientific advice on specific Scottish issues, or on wider UK and international issues which have an impact on Scotland, is available to Scottish Ministers.

## SCIENCE AND THE PUBLIC

14. There are a range of issues surrounding public perception of science, the need to have a more open and knowledgeable debate in public on scientific matters of genuine public interest and concern, and the use and explanation of scientific advice to the public. The Group feel these are sufficiently important to highlight them specifically as meriting a place in a Scottish science strategy.

15. There is, for example, a perception that science involves "certainty". However, while scientific knowledge is based on certain rigorous principles it can never be complete and the impression of 'absolute fact' is incorrect. A key question is therefore how to generate a better understanding and acceptance of scientific uncertainty and risk. The public is often prepared to accept a degree of risk if they are properly informed of the trade-off between the risks and the benefits. Conversely, scientific advisory systems should take full account of



the public's perceptions of science and risk. An understanding of risk is central to any evidence-based policy process.

16. The view that science is too complex and difficult for the public to understand should also be challenged. This is a three-way process and requires the engagement of not only scientists and the public but also the media who have a major role to play in this area. However the explanation of complex scientific principles and understandings is not easy. Further questions for a strategy are therefore how to secure a debate on scientific issues with the public, how to assist the media in presenting science and its role in policy, and how to address the issues of communication skills for scientists, and help improve public understanding of science (in which school education can also play a significant role).

17. A related issue is how to build up the degree of trust between scientific experts and the public when different scientific opinions on a difficult or novel piece of science may be equally defensible in the light of existing knowledge. This is a particularly sensitive issue when public concern is high. Truly independent scientific advice can be difficult to obtain but the key is to access advice that is accepted as being objective, balanced and deals with uncertainty in a credible fashion.

18. A key to this may be that scientific experts should be willing to participate in open debate. This will inevitably result in a wide range of views and interpretations. The question for a science strategy is to identify processes that can cope with such problems. The public have an important input to make, especially on ethical issues and on how science impacts on quality of life. Increased consultation over scientific issues of public concern, while carrying resource implications, should provide substantial long-term benefits with the public being more fully committed to new initiatives and policies.

## **SCIENCE AND EDUCATION**

19. Science-teaching in schools is an important cross-cutting issue for a science strategy. It can enhance public understanding of science, ensure that tomorrow's leaders of industry have the background to take advantage of technological opportunities, ensure that science is embedded in policy-makers' thinking, and provide the seed-corn for the next generation of developers of the science base and of specialists to meet the technological needs of the industrial (especially SME) base.

20. In the Group's discussions it was highlighted that Scotland has in many respects led the way in terms of curriculum innovation, levels of pupil participation and attainment in science courses, and – in secondary schools – the use of a well-qualified teaching force. However questions arise about how to arrest the fall-off in interest and attainment at upper primary and lower secondary levels (at a time when pupils are beginning to develop ideas on choices for the future), how to address the relatively low levels of scientific training in primary school teachers (and a concomitant lack of confidence in teaching the general science curriculum at that level), and what mechanisms should be put in place to provide for the continuing professional development of specialist science teachers in secondary schools as scientific knowledge expands.

21. So far as the curriculum is concerned, a strategy would need to address the question of whether further development in curriculum content is required. For example, is the existing emphasis on a general scientific education and scientific literacy - and its relevance to

modern lifestyles and careers – sufficient, and is there adequate provision for those pupils who wish to specialise in science and pursue it in the tertiary education sector? A further question is how to provide for the enhanced physical infrastructure (laboratories and equipment) that is required in many schools, and the implications of this for the effectiveness of science teaching.

22. Finally, the Group note that many companies have an outreach programme supporting science education in schools. This type of activity is patchy, but where it is done well it not only provides an educational opportunity for pupils and indeed teachers but also plays an important role in the promotion of career opportunities for well qualified scientists. Such an initiative may also provide an opportunity for Scotland to link its business strengths to realistic career opportunities for school pupils. The question here is how to build on existing activity in this area and to engage companies more in school education.

23. The Group understand that many of the questions set out in this section are already being addressed by the Scottish Executive Education Department, but sees the inclusion of science education in a Scottish science strategy as essential given its underpinning importance to the development and use of science generally.

## **THE SCIENCE BASE IN SCOTLAND**

24. Scotland needs a vigorous science base in order to provide for continued high-level input to the issues identified so far in this report. Thus a science base: provides the output of new knowledge, concepts and processes which regenerate the capabilities of industry and commerce; provides newly-trained scientists who support the needs of Government policy, teaching and innovation in industry; and supplies scientific knowledge and understanding which make vital contributions to wealth creation and to policies designed to improve quality of life, in health, education and the environment.

25. Questions for a science strategy in this area are therefore: how to preserve and enhance the excellence and diversity of the Scottish science base; how to strike the right balance between encouraging competition and promoting collaboration; how to encourage multidisciplinary working as scientific problems become more complex and require a range of disciplines and skills for their advancement; and what balance to strike between, on the one hand, research aimed at scientific curiosity and the pursuit of new knowledge for its own sake, and on the other, the generation of knowledge and technology - through applied research - which is more immediately relevant to user communities.

26. Another crucial question for the science base in Scotland is how to maintain the skills base and specifically to provide adequate career paths for research staff. The pressure of competition for research funds – as a key spur to excellence – has led to significant numbers of innovative researchers being employed on a series of short-term contracts. Efforts to resolve this issue have been made both at the UK level and within Scotland by the Scottish Higher Education Funding Council (SHEFC). Scotland could give the lead in addressing this question further and in providing enhanced linkages between research workers and industry, and in facilitating the career paths for scientists which will be essential to maintain this skills base in the longer term. It is also important to provide for lifelong learning for the scientific community, in order to update continually the skills base.



27. The Scottish Executive therefore needs to develop a clear policy for the science base in Scotland. Central to this will be the role and effectiveness of SHEFC who are major funders of the science base in Scotland. The majority of SHEFC research funding is based on a retrospective analysis of research quality, the Research Assessment Exercise, and there is no clear correspondence between the resultant pattern of funding across subject areas and the drivers of growth and wealth creation in Scotland. Instead SHEFC has separate funding mechanisms to address the latter issues. The rewarding of scientific excellence is essential for the pursuit of blue skies research and to maintain the refreshment and diversity of the research base that will lead to future economic benefits and to benefits in quality of life in Scotland. However, adequate support for applied research and development is also essential. The question for a science strategy will be how to set a framework of policies, priorities and objectives which could help shape SHEFC's funding of the science in order to meet these various requirements in a balanced way, and to ensure that the criteria on which funding of research in Higher Education is based are appropriate to the needs of Scotland in the 21<sup>st</sup> Century.

28. The Scottish science base is, however, supported not only by SHEFC but by the UK Research Councils, by the Scottish Executive Rural Affairs Department's sponsorship of the Scottish Agricultural and Biological Research Institutes (SABRIs), by the Scottish Executive Health Department's research programme, and by other significant funders such as the medical research charities. At present these funding streams are largely managed separately though linkages and liaison are maintained between these funders. Together they support a strong science base in areas where Scottish science is strong, but they have the potential to contribute in a more concerted way to science base issues in Scotland. A science strategy would need to address the questions of how to achieve a coherent and co-ordinated approach among the various funders and how to set priorities for research spend across the various budgets. This is something which the Scottish Executive is well positioned to do, particularly as regards the funding streams under its control.

## **THE UK AND INTERNATIONAL CONTEXT**

29. A key question for any Scottish science strategy is how it would link into science policy both at the UK level and in Europe and beyond. The Scottish science base cannot itself cover all of the science needs of Scotland. This reinforces the importance of maintaining and enhancing Scotland's relationship with the UK and international science bases – especially in Europe. Under the devolution settlement, certain aspects of science in Scotland are reserved to the UK Government, perhaps most notably the Research Councils who are key funders of the science base in Scotland but continue to operate on a UK basis. In addition, certain UK science policies are likely to apply equally to Scotland, such as the current guidelines on the Use of Scientific Advice in Policy Making. And other initiatives need to be organised on a UK or European basis (such as certain major international research projects). All this means that close integration with UK Government and European science policy will be essential. To weaken the existing strong links with the rest of the UK in particular would not be to Scotland's benefit. A strategy would need to address the question of how to sustain these links.

30. On the other hand, the profile of the needs of Scotland for science does differ from the UK more widely. For example the conduct of 'Foresight' exercises to guide the long-term development of science and its use in industry, will require to take account of the differing economic and science circumstances/strengths in Scotland. And within Scotland itself there

are regional differences which need to be taken into account. A question for the strategy would therefore be how to address these distinctive needs in Scotland while continuing to link into the wider context and drawing as necessary on the UK science base.

31. A final contextual issue is the unique contribution which Scottish science can make to the UK and internationally. It is most important that, alongside the pressures which devolution brings for increased decision-making in Scotland, Scottish scientists are able to continue to contribute to science and science policy-making in UK and international fora, and indeed to represent Scottish science at those levels. How this can be achieved is another key question for a strategy.

32. Overall, therefore, science is a global activity and a Scottish science strategy would need to fit in with, draw upon, and contribute to science at the UK, European and international levels while at the same time capitalising on specific Scottish opportunities and addressing specific Scottish needs.

## **CASE FOR A SCOTTISH SCIENCE STRATEGY**

33. In this report, the Review Group have identified a range of key issues surrounding the provision and use of science in Scotland, and the related questions which need to be addressed. Science has an important role in supporting the Scottish economy as well as contributing to many aspects of Scottish quality of life such as health and the environment, and more generally science plays an important role in underpinning a wide range of Scottish Executive functions and policies. These benefits are, however, delivered through a wide variety of mechanisms and agencies, involving different departments of the Scottish Executive, other public bodies, universities, research councils and industry itself. And although there are clear linkages between the various issues identified in this report, there is no overarching strategic framework for the provision and use of science in Scotland.

34. Devolution brings a new political environment to such issues and is likely to lead to a greater scrutiny of the existing arrangements by the Scottish Parliament. It also provides the stimulus for a distinctive and explicit policy for science in Scotland to be articulated, taking account of Scottish circumstances, needs, strengths and opportunities. Indeed there may increasingly be an expectation that, given Scottish strengths in science, such an explicit and public strategy should be formulated.

35. A strategy linking the various streams of science activity and endeavour in Scotland, and the various issues and key questions set out in this report, would: bring a greater coherence and consistency to the use of science in policy; support an increased use of evidence-based policy-making; facilitate the development of an explicit hierarchy of objectives for science leading to a determination of strategic priorities; help to inform decisions on prioritisation of resources; and act as a catalyst for realising synergies between and among these various scientific streams. It would provide a framework within which the Scottish Executive could exercise its devolved powers in relation to science and research, including the setting of priorities for expenditure on research. Further, a cross-cutting strategy of this type would bring a new emphasis to the provision and use of science in Scotland and so bring a new thrust to wealth creation and improved quality of life, for both of which science is such a key driver and supplier.



36. A science strategy for Scotland would, however, have to be outward looking, recognising the broader UK, European and global science contexts while also focusing on what Scotland actually wants from science. The strategy would take into account the needs and responsibilities of a diverse set of stakeholders including Ministers, the public, scientists and the business and industry community. And it would have to dovetail with other related strategies for Scotland, such as for the economy, for the environment and for health.

## **DEVELOPMENT AND IMPLEMENTATION OF A SCIENCE STRATEGY**

37. Against the background of the need for a cross-cutting science strategy, and the questions which require to be addressed, the Group have considered what would be required to develop and implement a science strategy.

38. Considerable further work will be required in order to put a strategy in place. And it will be essential during that process to consult early and widely with a range of stakeholders. The Group suggest that a strategy should set out a clear set of aims and policies for science in Scotland, covering the issues and questions identified in this report, but that it should allow for their further evolution as circumstances change over time. A cross-cutting strategy would be geared to adding value to and supplementing the existing strategies and policies pursued by the range of Scottish Executive departments and sponsored public bodies dealing with science.

39. In order to implement a strategy the Group see a need for three key elements:

- (a) A high level and independent advisory body, providing advice to the Executive on science strategy, science policy and priorities. This would complement existing scientific advisory mechanisms provided from within the executive itself or through participation in the extensive UK scientific advisory committee system.
- (b) A strengthened capability embedded in the Scottish Executive to provide co-ordination of science issues within the Executive, to support the implementation of the Scottish science strategy, and to support the external advisory body.
- (c) A mechanism for Ministers in the Scottish Executive to meet to discuss cross-cutting science issues when necessary.

40. The Group did not have a clear view on whether Scottish Ministers should appoint a Chief Scientific Adviser, but were clear that there was an important representational role to be played within Government, either by the Chairman and members of the proposed advisory body or by the recommended strengthened capability within the Executive. This issue should therefore be considered in the context of those recommendations and of the proposed comprehensive framework for the provision of scientific advice to Scottish Ministers.

## **Science Strategy Review Group**

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Professor Sir W D P Stewart FRS FRSE – President of the Royal Society of Edinburgh; former Chief Scientific Advisor to the UK Government (1990-95).

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SCOTTISH EXECUTIVE

**Making it work together**

This report is available on the Scottish Executive's web site at [www.scotland.gov.uk](http://www.scotland.gov.uk)

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